

SYSTEMATICS AND TAXONOMIC REMARKS ON
PINNOTHERES MULINIARUM RATHBUN, 1918
(CRUSTACEA: BRACHYURA: PINNOTHERIDAE)

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Abstract.—The new genus *Juxtafabia* is proposed to receive the clam crab *Pinnotheres muliniarum* Rathbun, 1918. The primary diagnostic features are: third maxilliped with carpus and propodus stout, subequal in length; propodus suboblong, with distal end obliquely rounded and a lunate and broad dactylus inserted near its proximal end; and male abdomen widest at somite 3, narrowing at somite 4 which is fused to somite 5, and telson longer than broad. The type species, *Pinnotheres muliniarum* Rathbun, 1918, described from a pre-hard stage male is considered to be a senior synonym of *P. reticulatus* Rathbun, 1918, which was described on the basis of an adult female. Description and figures of the young pre-hard stage, adult hard stage male, adult female, complete synonymy, known distribution, and host are presented.

Resúmen.—El nuevo género *Juxtafabia* se propone para recibir al cangrejo almejero *Pinnotheres muliniarum* Rathbun, 1918. Sus características diagnósticas primarias son: tercer maxilipedio con el carpus y propodus iguales en longitud y robustos; el propodus suboblongo tiene su final distal oblicuamente redondeado y lleva proximoventralmente al amplio y lunado dactilus; y el abdómen, en el macho, se ensancha en el somita 3, se adelgaza en el 4 el cual está fusionado al 5, y con un telson más largo que ancho. La especie tipo, *Pinnotheres muliniarum* Rathbun, 1918, que fue descrita en base a un macho en fase predura es aquí considerado como un sinónimo antiguo de *P. reticulatus* Rathbun, 1918, la cual fue descrita sobre la base de una hembra adulta. Descripción y figuras de las fases masculinas pre-dura y dura, la hembra adulta, la sinonimia completa, la distribución conocida y los huéspedes para esta especie, se registran.

The Pinnotheridae is a group of symbiotic and sexually dimorphic crabs that undergo a series of morphological changes during their postplanktonic development. This has resulted in some mistaken identifications representing developmental stages of the same species. For example, Williams (1965) found that *Pinnotheres depressus* Rathbun, 1918 was the pre-hard stage male of *P. ostreum* Say, 1817, and Campos (1989b) concluded that *P. pubescens* (Holmes, 1894) is a young female of *Tumidotheres margarita* (Smith, 1869). Recently, Green (1985) de-

termined that *P. jamesi* Rathbun, 1923, described from a hard stage male (sensu Christensen & McDermott 1958) is a junior synonym of *P. reticulatus* Rathbun, 1918, a species which was described on the basis of a post-hard stage female. Postplanktonic stages of *P. reticulatus* collected in the upper Gulf of California in 1986–1987 confirmed Green's conclusions, and a comparison of the pre-hard stage male with the holotype of *P. muliniarum* Rathbun, 1918 revealed no difference. In addition, a morphological analysis of these specimens has led to the

proposition of a new genus for this species. This new genus most closely resembles *Fabia* Dana, 1851.

Specimens for this study were obtained from: National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); Colección Carcinológica, Instituto de Biología, Universidad Nacional Autónoma de México (EM) and Facultad de Ciencias, Universidad Autónoma de Baja California (UABC). The abbreviation cw refers to carapace width.

Systematics and Taxonomic Account

Juxtafabia, new genus

Diagnosis.—Female carapace subglobular, dorsal regions weakly defined. Third maxilliped with ischium and merus indistinguishably fused, ventral margin angular, dorsal margin gently convex; palp slightly shorter than ischium-merus, carpus and propodus subequal in length, stout, latter article suboblong with distal end obliquely rounded, dactylus lunate, broad, ventrally inserted near proximal end of propodus. Abdomen with 7 free somites, laterally reaching to coxae of walking legs, distally covering buccal cavity.

Male carapace subglobular, regions weakly defined, pterygostomian region elevated, eyes visible in dorsal view; third maxilliped similar to that of female; abdomen widest at somite 3, narrowing at somite 4 which is fused to somite 5, telson longer than broad.

Type species.—By present designation and monotypy, *Pinnotheres muliniarum* Rathbun, 1918. Gender feminine.

Distribution.—Upper Gulf of California, México to Costa Rica, Central America.

Hosts.—Mollusca, Bivalvia: species of *Chione*, *Polymesoda*, *Protothaca* and *Tagelus*.

Etymology.—The generic name is derived from the latin *Juxta*, close to, at side of, and the generic name *Fabia*. The name has been selected to emphasize the resemblance of *Juxtafabia* and *Fabia*.

Remarks.—Other genera in the Pinnotheridae which also have the ischium and merus of the third maxilliped indistinguishably fused differ from *Juxtafabia* as follows: *Dissodactylus* Smith, 1870, *Clypeasterophilus* Campos & Griffith, 1990, *Parapinnixa* Holmes, 1894 and *Sakaina* Serène, 1964 have an exopod without flagellum (Fig. 1A); *Calyptraeotheres* Campos, 1990, *Ostracotheres* H. Milne-Edwards, 1853 and *Xanthasia* White, 1846 have a palp with two articles (Fig. 1B); *Limotheres* Holthuis, 1975 and *Orthotheres* Sakai, 1969 have the dactylus inserted distally on the propodus (Fig. 1C); *Pinnixa* White, 1846 and *Scleroplax* Rathbun, 1893 have a lobe on the external margin of the exopod (Fig. 1D); *Fabia* Dana, 1851, *Tumidotheres* Campos, 1989b, and *Durckheimia* De Man, 1889, have a small palp with the dactylus inserted on the middle of the propodus (Fig. 1E); and *Pinnotheres* Bosc, 1802 s. str. has a linear and slender dactylus inserted proximally on the inner margin of the spatulate propodus (Fig. 1F), and seven free abdominal somites. Additional differences between *Juxtafabia* and the above genera can be found in Bürger (1895), Rathbun (1918), Tesch (1918), Serène (1964, 1967), Holthuis (1975), Campos (1989a, 1989b, 1990) and Campos & Griffith (1990).

The new genus *Juxtafabia* most closely resembles the genus *Fabia*. Males in both genera have two or more abdominal somites fused. However, there are no morphological similarities between females of the two genera. Larvae of *J. muliniarum* resemble zoeae of *Fabia* and *Pinnixa*. Zoeae in these genera have a common pattern of setae on their appendages, a carapace with moderately developed rostral, lateral and dorsal spines and a distinctive abdominal shape. These genera share a very distinct lateral and posterior expansion on the fifth abdominal somite (Fig. 2A–E). The genus *Pinnixa*, however, has an elongated telson which is quite distinct from that in *Juxtafabia* and *Fabia*. Whether these morphological similarities

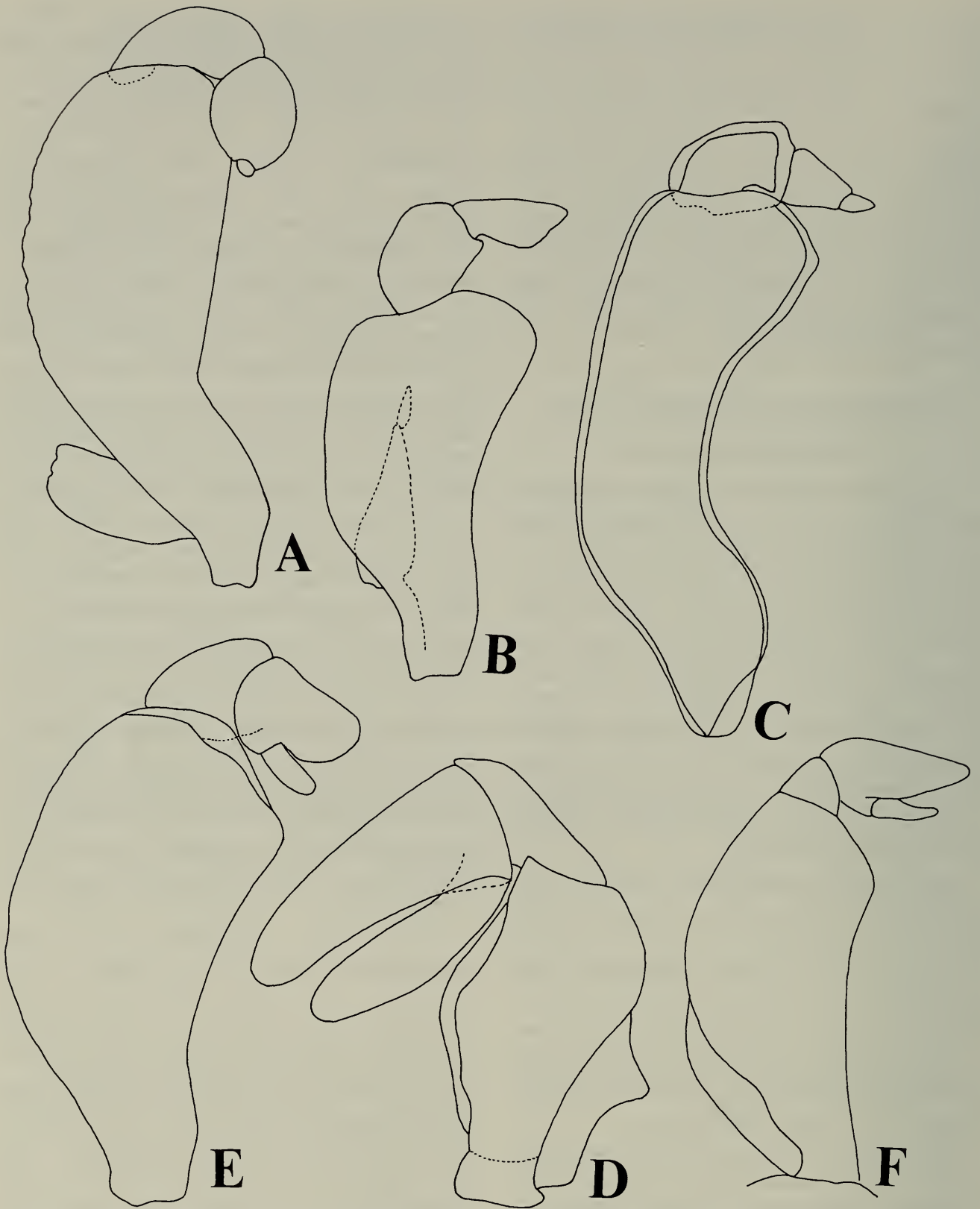


Fig. 1. Third maxilliped. A, *Dissodactylus lockingtoni* Glassell, 1935; B, *Calyptraeotheres granti* (Glassell, 1933); C, *Orthotheses unguifalcula* (Glassell, 1935); D, *Scleroplax granulata* Rathbun, 1893; E, *Fabia* sp.; F, *Pinnotheres pisum* (Linnaeus, 1767). [F, redrawn from Ingle (1980:52, fig. 25)].

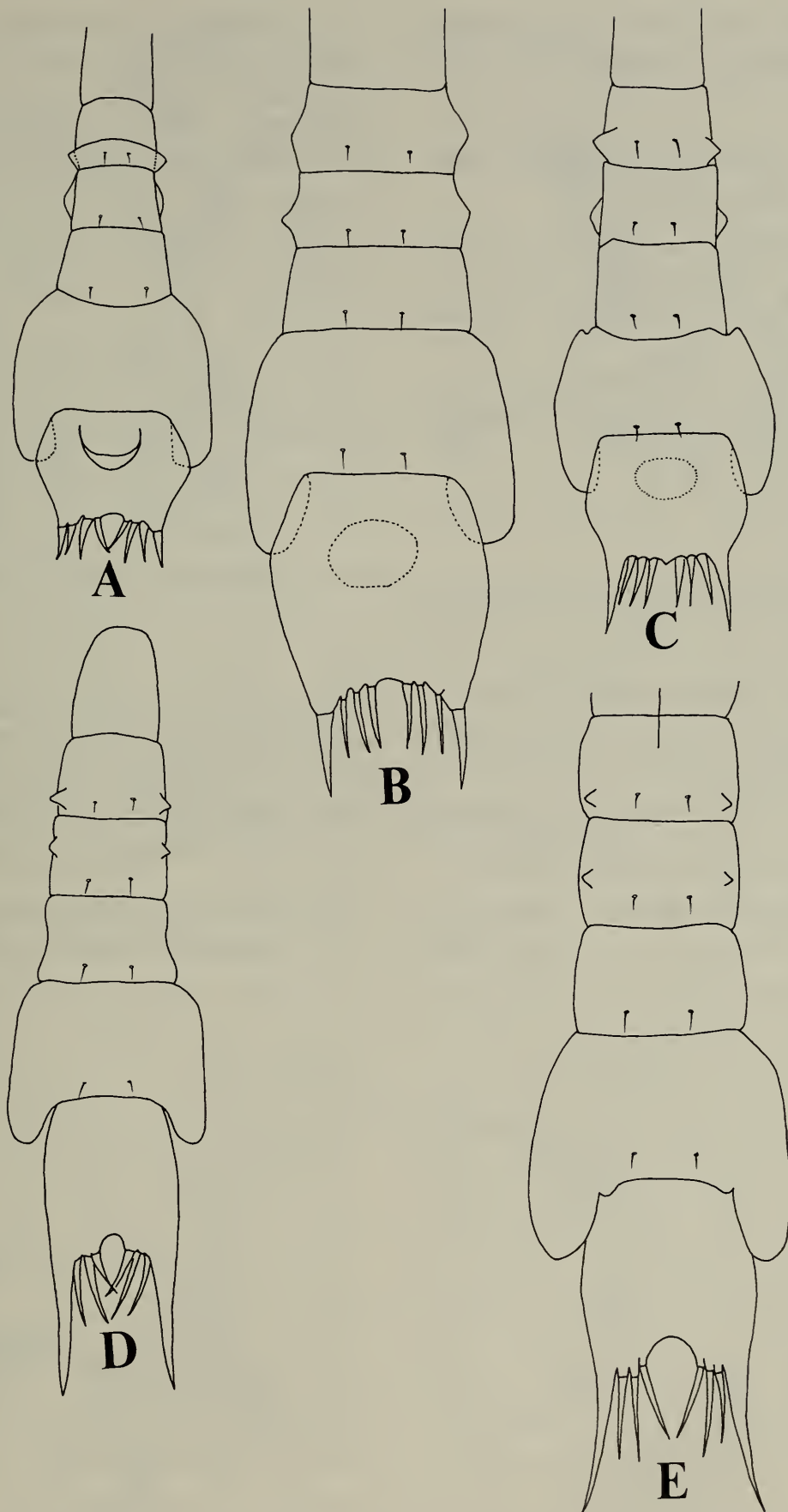


Fig. 2. Dorsal view of zoeal abdomen. A, *Juxtafabia muliniarum* (Rathbun, 1918); B, *Fabia subquadrata* Dana, 1851; C, *Fabia* sp.; D, *Pinnixa longipes* (Lockington, 1877); E, *Pinnixa* aff. *rathbuni* Sakai, 1934 [D and E redrawn from Bousquette (1980:596, fig. 4A) and Konichi (1983:282, fig. 14C) respectively].

between males and larvae have phylogenetic implications remains to be determined.

Juxtafabia muliniarum (Rathbun, 1918),
new combination

Pinnotheres muliniarum Rathbun, 1918: 81, pl. 18, figs. 2, 3.—Glassell 1934:301.—Schmitt et al. 1973:5, 10, 58.—Campos 1989b:672.

Pinnotheres reticulatus Rathbun, 1918:93–94, pl. 21, figs. 1, 2.—Glassell 1934:301; 1935:105.—Schmitt et al. 1973:5, 83.—Green 1985: 611–614, figs. 1, 2.—Campos-González 1988:385.—Campos 1989b:672.

Pinnotheres jamesi Rathbun, 1923:625–626, pl. 29, figs. 1, 2, text-figs. 1, 2.—Glassell 1934:301.—Silas & Alagarwami 1967: 1200, 1223.—Schmitt et al. 1973:50.

Type locality.—Lower California (Baja California, Mexico).

Distribution.—Gulf of Santa Clara (Gulf of California), Baja California, Mexico to Costa Rica.

Hosts.—Mollusca, Bivalvia: *Chione californiensis* (Broderip), *C. fructifaga* (Sowerby), *C. tumens* (Verrill), *Polymesoda inflata* (Philippi), *Protothaca grata* (Say) and *Tagelus affinis* (C. B. Adams).

Material examined.—Holotype of *Pinnotheres muliniarum*, Lower California, male, cw 3.6 mm (fide Rathbun 1918), USNM 23443.—Holotype of *P. reticulatus*, off San Jose Island, Baja California Sur, 25°02'15"N, 110°43'30"W, 17 fms (31 m), S.Sh., 17 Mar 1889, Station 3002 Albatross, female, cw 9.2 mm (fide Rathbun 1918), USNM 18217.—1 female, cw 2.9 mm, Gulf of Santa Clara, Baja California, 25 Apr 1990, in *Chione fructifaga*, UABC.—12 ovigerous females, cw 5 to 10 mm, 4 young males, cw 1 to 2.2 mm, Campo El Pescador, on coast 4.5 km North of San Felipe, Baja California, 1988, in *Protothaca grata*, *Chione californiensis* and *C. fructifaga*, UABC.—7 young males, cw 1 to 2.3 mm, 11 adult males, cw

2.2 to 3.4 mm, and 30 females, cw 4 to 10 mm, Laguna Pecebú, about 23 km south of San Felipe, 1987–88, in *P. grata* and *Tagelus affinis*, UABC.—1 female, cw 5.7 mm, Puertecitos, km 72 road San Felipe-San Luis Gonzága, Aug 1986, in *P. grata*, UABC.—1 ovigerous female, cw 10 mm, San Marcos Island, north of La Yesera (27°17'N, 112°07'W), 16 May 1987, in *Chione tumens*, EM.

Male pre-hard stage.—Carapace transversely subglobular, soft, posterior margin convex; front slightly projected and strongly deflexed (Fig. 3). Third maxilliped with palp slightly shorter than ischium-merus (Fig. 5A); carpus subequal to propodus in length, latter suboblong, with distal end obliquely rounded; dactylus broad, lunate, ventrally inserted near proximal end of propodus, nearly reaching to distal end of last article.

Chelipeds stouter than walking legs, merus widening slightly distally, dorsal margin convex, ventral margin straight; fingers subequal, slightly deflexed, curved at tip where they cross; cutting edge of dactylus with small tooth.

Relative length of the walking legs $2 > 3 > 1 > 4$, fourth leg not overreaching carpus of third leg; margin of legs hairy, specially on meri; dorsal margin of propodi convex, ventral margin in legs 1–3 straight, concave in leg 4; dactyli 1–3 hook-like; dactylus 4 less curved than on legs 1–3.

Abdomen widest at somite 3, narrowing at somite 4, telson longer than broad, distally rounded. Somites 4 and 5 fused.

Gonopods simple, curved at base, distally straight (Fig. 5B).

Male hard stage.—Carapace (Fig. 4) transversely subglobular, well calcified, lateral margins with a heavy fringe of hair-like setae; pterygostomial region higher than in pre-hard stage so that eyes are more conspicuous in dorsal view; frontal region occasionally produced; posterior margin almost straight. Third maxilliped similar to that of male pre-hard stage (Fig. 5C).

Chelipeds no more stout than walking legs;



Fig. 3. *Juxtafabia muliniarum* (Rathbun, 1918); dorsal view of pre-hard stage male. Carapace length = 2.3 mm.

manus widening distally; dorsal margin convex; fingers subequal, curved and crossed at tip; ventral margin almost straight; pollex with 2 acute teeth on proximal half of cutting edge, between them a notch where truncate tooth of dactylus fits.

Walking legs stout, dorsal and ventral margin of meri fringed with setae; propodi

tapering distally, dorsally convex, almost straight ventrally; dactyli equal to those of pre-hard stage. External face of carpus and propodus of walking legs 2 and 3 with long swimming setae.

Abdomen similar to that of pre-hard stage, but somite 7 occasionally subrectangular (Fig. 5D).

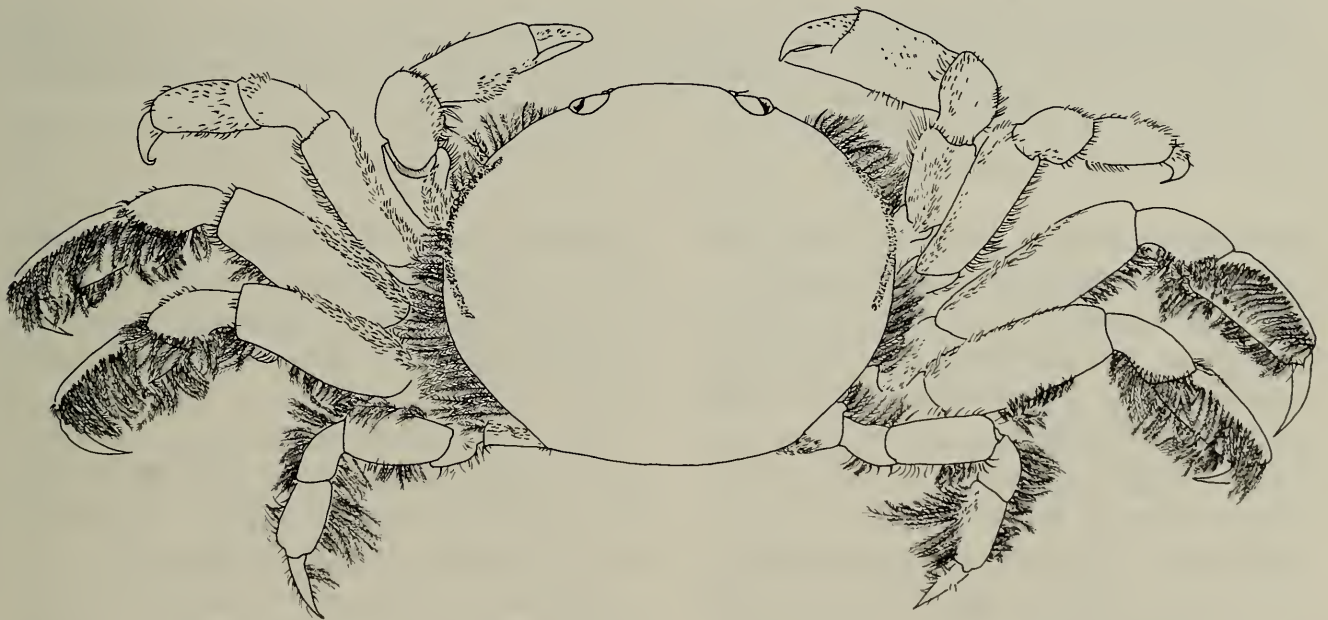


Fig. 4. *Juxtafabia muliniarum* (Rathbun, 1918); dorsal view of hard stage male. Carapace length = 3.14 mm. Single setae shown on dorsal and ventral margin of the last walking legs may actually be plumose setae.

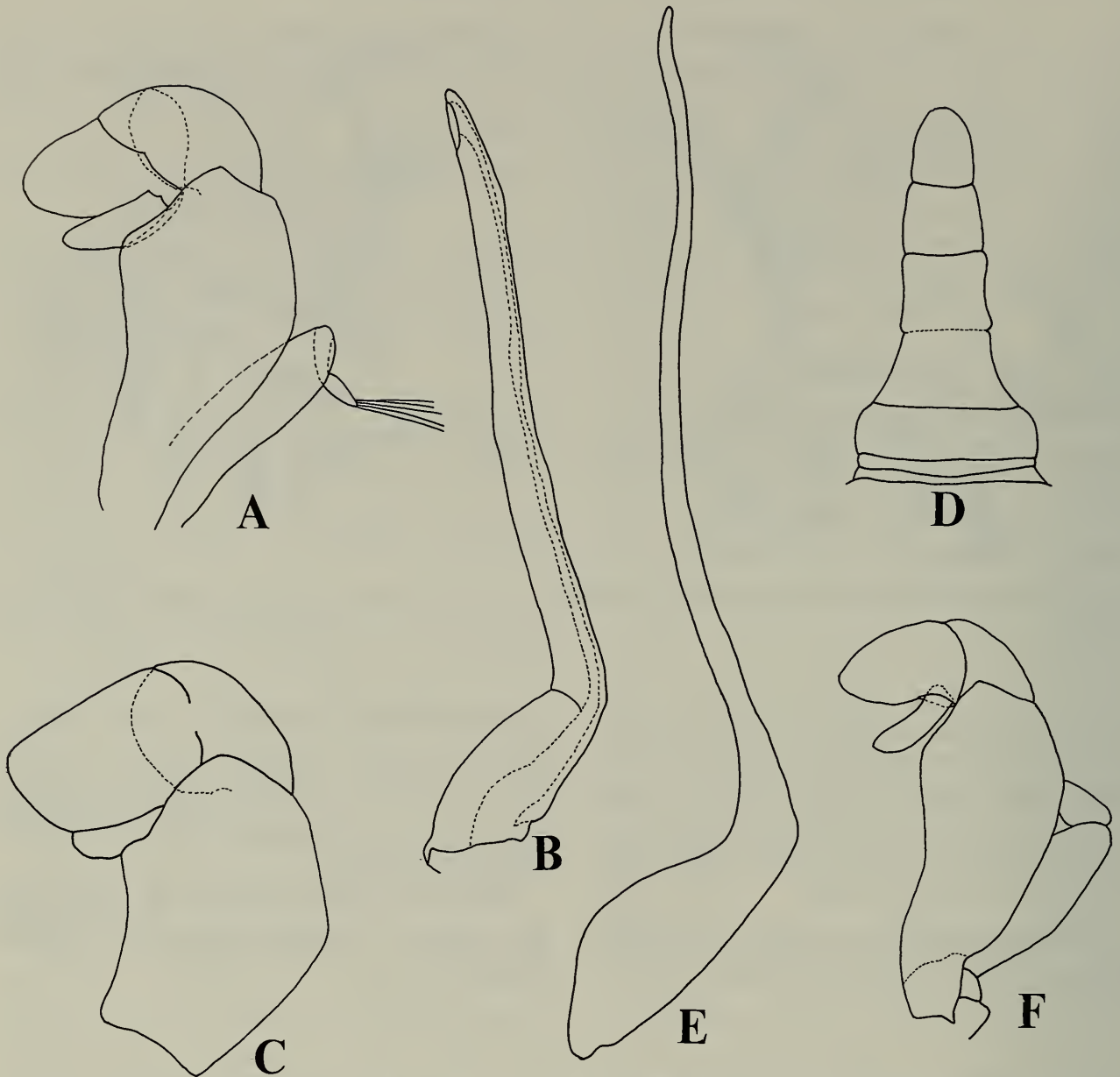


Fig. 5. *Juxtafabia muliniarum* (Rathbun, 1918). Pre-hard stage male: A, third maxilliped; B, gonopod. Hard stage male C, third maxilliped; D, abdomen; E, gonopod. F, third maxilliped of last post-hard stage female. [A and C-D redrawn from Rathbun (1918:81, fig. 38, and 1923:626, figs. 1 and 2)].

Gonopods similar to those in pre-hard stage, but longer and slender (Fig. 5E).

Female (ovigerous).—Carapace (Fig. 6) subglobular, broader than long, soft, slightly convex; gastric region elevated on medial line and separated by broad depression from branchial region; a lunate depression near hepatic margin. Front slightly convex in dorsal view, scarcely projecting beyond curve of anterolateral margin. Eyes globular, completely filling orbits, visible dorsally, cornea evident. Epistome and labium

similar in length and width. Antenna with blocky basal articles, flagellum minute, not overreaching upper margin of orbit. Antennulae placed in wide fossettes not larger than orbits.

First 2 articles of palp of third maxilliped broad, subequal in length; dactylus curved, lunate, attached proximally and reaching to end of suboblong propodus (Fig. 5F).

Chelipeds and legs short, pubescent; chelipeds hairy on inner faces; manus subelliptical, increasing slightly distally, lower mar-

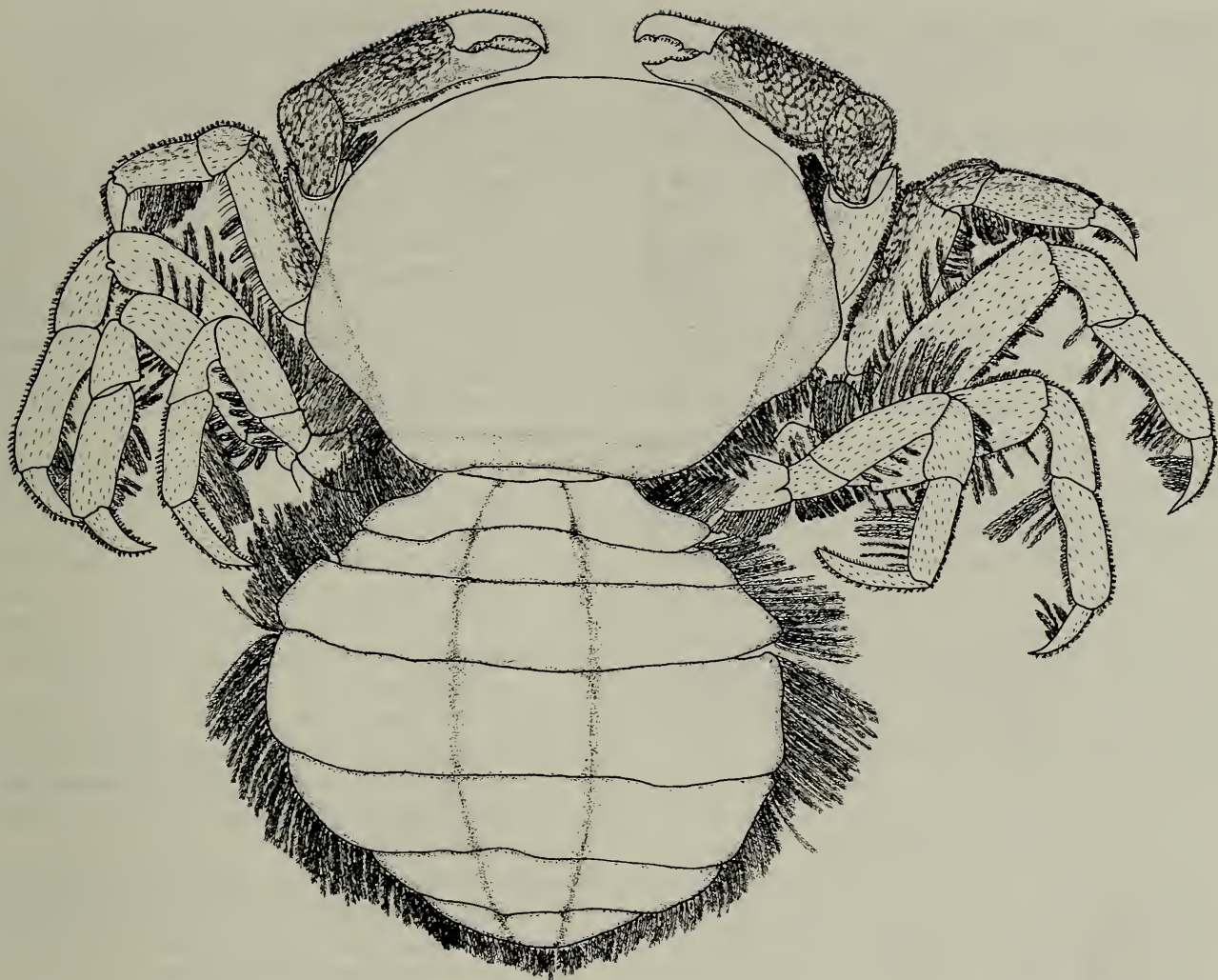


Fig. 6. *Juxtafabia muliniarum* (Rathbun, 1918); dorsal view of adult female. Carapace length = 7 mm. (Eyes are dorsally visible when abdomen is folded towards carapace sternum).

gin straight, upper slightly convex; pubescence arranged in reticulate pattern, the interstices of which are smooth and of darker color (in alcohol); fingers moderately stout, tips hooked toward each other, prehensile edges of each armed with 2 teeth of which that near base of dactylus is largest, other minute teeth between them.

Walking legs furnished with long setae on lower margin, specially on propodus of first and fourth leg; relative length of legs $2 > 3 > 4 > 1$, the second leg may be asymmetrical, with propodus and dactylus of left leg longer than on right one; ventral margin of propodus of second and third leg concave; ventral margin of propodus of first and fourth leg straight; dactyli 1, 2 and 3 similar, curved and with slender tips, first shortest,

second longest; dactylus 4 much longer than those preceding and may be longer than its propodus.

Abdomen with 7 free somites, longer and broader than carapace (modified from Rathbun 1918).

Remarks.—The study of males in hard stage (host, *Tagelus affinis*) and females in post-hard stage (host, *Protothaca grata* and *T. affinis*) collected during the spring and summer of 1986–1987 at Laguna Percebú, south of San Felipe, led to the confirmation of Green's (1985) conclusion that *Pinnotheres jamesi* is a junior synonym of *P. reticulatus*. Subsequent collecting of pre-hard stage males (host, *Chione californiensis*) of a pinnotherid crab from Campo El Pescador showed no difference with Rathbun's (1918)

holotype of *Juxtafabia muliniarum*. Examination of additional males collected from *T. affinis* showed that some specimens represented pre-hard stage males which were identical to those previously identified as *J. muliniarum* (from El Pescador). The other specimens were hard stage males identical to *P. jamesi*. To determine whether both types of males examined were conspecific, specimens of pre-hard stage males (= *J. muliniarum*) were kept alive until they molted to a hard stage identical to those identified as *P. jamesi*. These results and the study of the complete postplanktonic female stages from San Felipe and vicinity, led to the conclusion that *J. muliniarum*, *P. jamesi* and *P. reticulatus* represent the same species. *Juxtafabia muliniarum* was the first named species and, therefore, is the senior synonym of the other two taxa.

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Literature Cited

- Bosc, L. A-G. 1802. Histoire naturelle des Crustacés, contenant leur description et leurs moeurs, avec figures dessinées d'après nature. Deterville, Paris, 1:1-258, pls. 1-8.
- Bousquette, G. D. 1980. The larval development of *Pinnixa longipes* (Lockington, 1877) (Brachyura, Pinnotheridae) reared in the laboratory.— *Biological Bulletin* 159:592-605.
- Bürger, O. 1895. Ein Beitrag zur Kenntniss der Pinnotherinen.— *Zoologische Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere* 8:361-390.
- Campos, E. 1989a. Comments on taxonomy of the genus *Orthothes* Sakai, 1969 (Crustacea, Brachyura, Pinnotheridae).— *Bulletin of Marine Science* 44(3):1123-1128.
- . 1989b. *Tumidothes* a new genus for *Pinnotheres margarita* Smith, 1869, and *Pinnotheres maculatus* Say, 1818 (Brachyura: Pinnotheridae).— *Journal of Crustacean Biology* 9:672-679.
- . 1990. *Calyptraeotheres*, a new genus of Pinnotheridae for the limpet crab *Fabia granti* Glassell, 1933 (Crustacea, Brachyura).— *Proceedings of the Biological Society of Washington* 103:364-371.
- , & H. Griffith. 1990. *Clypeasterophilus*, a new genus to receive the small-palped species of the *Dissodactylus* complex (Brachyura: Pinnotheridae).— *Journal of Crustacean Biology* 10:550-553.
- Campos-González, E. 1988. New molluscan hosts for two shrimps and two crabs on the coast of Baja California, with some remarks on distribution.— *The Veliger* 30:384-386.
- Christensen, A. M., & J. J. McDermott. 1958. Life-history and biology of the oyster crab, *Pinnotheres ostreum* Say.— *Biological Bulletin* 114:146-179.
- Dana, J. D. 1851. On the classification of the Crustacea Grapsoidea.— *American Journal of Science and Arts, series 2*, 12:283-291.
- De Man, J. G. 1889. Ueber einige oder seltene Indopacifische Brachyuren.— *Zoologische Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere* 4:409-452.
- Glassell, S. A. 1933. Description of five new species of Brachyura collected on the west coast of Mexico.— *Transactions of the San Diego Society of Natural History* 7:331-334.
- . 1934. Affinities of the brachyuran fauna of the Gulf of California.— *Journal of Washington Academy of Science* 24:296-302.
- . 1935. New or little known crabs from the Pacific coast of Northern Mexico.— *Transaction of the San Diego Society of Natural History* 8:91-106.
- Green, T. M. 1985. *Pinnotheres jamesi* synonymized with *P. reticulatus* (Decapoda: Brachyura).— *Proceedings of the Biological Society of Washington* 98:611-614.

- Holmes, S. J. 1894. Notes on the West American Crustacea.—Proceedings of the California Academy of Sciences, series 2, 4:563–588.
- Holthuis, L. B. 1975. *Limotheres*, a new genus of pinnotherid crab, commensal of the bivalve *Lima*, from the Caribbean sea.—Zoologische Mededelingen (Leiden) 48(25):291–295.
- Ingle, R. W. 1980. British crabs. British Museum (Natural History). Oxford University Press, 213 pp.
- Konishi, K. 1983. Larvae of pinnotherid crabs (Crustacea: Brachyura) found in the plankton of Oshoro Bay, Hokkaido.—Journal of the Faculty of Science, Hokkaido University serie VI, Zoology 23(3):266–295.
- Linnaeus, C. 1767. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Edition 12, 1(2):533–1327.
- Lockington, W. N. 1877. Description of a new genus and species of Crustacea.—Proceedings of the California Academy of Science 7:55–56.
- Milne-Edwards, H. 1853. Mémoires sur la famille des Ocypodiens, suite.—Annales des Sciences Naturelles, serie 3 (Zoologie) 20:163–228.
- Rathbun, M. J. 1893. Scientific results of explorations by the U.S. Fish Commission Steamer Albatross. XXIV. Descriptions of new genera and species of crabs from the west coast of North America and the Sandwich Islands.—Proceedings of the United States National Museum 16: 223–260.
- . 1918. The grapsoid crabs of America.—United States National Museum Bulletin 97:1–461.
- . 1923. The brachyuran crabs collected by the U.S. Fisheries steamer “Albatross” in 1911, chiefly on the west coast of Mexico.—Bulletin of the American Museum of Natural History 48:619–637.
- Sakai, T. 1934. Species of the genus *Pinnixa* (Pinnotherid crabs) found in the Far East.—Scientific Reports of the Tokyo Bunrika Daigaku (B) 2(29):37–43.
- . 1969. Two new genera and twenty-two new species of crabs from Japan.—Proceedings of the Biological Society of Washington 82:243–280.
- Say, T. 1817–1818. An account of the Crustacea of the United States.—Journal of the Academy of Natural Sciences of Philadelphia, 1(1–2):57–63, 65–80, 97–101, 155–160, 161–169 [all 1817], 235–253, 313–316, 317–319, 374–380, 381–401, 423–441 [all 1818].
- Schmitt, W. L., J. C. McCain, & E. S. Davidson. 1973. Decapoda I. Brachyura I. Family Pinnotheridae. In H. E. Gruner, & L. B. Holthuis, eds., Crustaceorum catalogus. W. Junk. B.V.: Den Haag, 160 pp.
- Serène, R. 1964. Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916, 80: Goneplacidae et Pinnotheridae, Récoltes par le Dr. Mortensen. Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhavn 126:181–282.
- . 1967. Sur deux espèces nouvelles de brachyures (Crustacés Décapodes) et sur une troisième peu connue, récoltées dans la région Malaise.—Bulletin du Muséum National d'Historie Naturelle, 2e série 38(6):817–827.
- Silas, E. G., & K. Alagarswami. 1967. On an instance of parasitization by the pea-crab (*Pinnotheres* sp.) on the black water clam (*Meretrix casta* (Chemnitz)) from India, with a review of the work on the systematics, ecology, biology and ethology of pea-crabs of the genus *Pinnotheres* Latreille.—Proceedings of the Symposium on Crustacea, Marine Biological Association of India 2:1161–1227.
- Smith, S. I. 1869. *Pinnotheres margarita* Smith, sp. nov. In A. E. Verrill, ed., On the parasitic habits of crustacea.—American Naturalist 3:245.
- . 1870. Notes on American Crustacea: No 1. Ocypodoidea.—Transaction of the Connecticut Academy of Science 2:113–176.
- Tesch, J. J. 1918. The Decapoda Brachyura of the Siboga expedition.—Siboga Expeditie 39c²:149–295.
- White, A. 1846. Notes on four new genera of Crustacea.—Annals and Magazine of Natural History 18 (118):176–178.
- Williams, A. B. 1965. Marine decapod crustaceans of the Carolinas.—Fishery Bulletin 65:i–xi, 1–298.

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